UNITED STATES DEPARTMENT OF AGRICULTURE

BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE

| Project | Date | Author |
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TITLE

# SOME IMPRESSIONS ON THE CYCLICAL FLUCTUATIONS OF INSECT CAUSED LOSSES IN NORTHEASTERN CALIFORNIA

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September 15, 1939

U. S. GOVERNMENT PRINTING OFFICE 8—9742

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# SOME IMPRESSIONS ON THE CYCLICAL FLUCTUATIONS OF INSECT CAUSED LOSSES IN NORTHEASTERN CALIFORNIA

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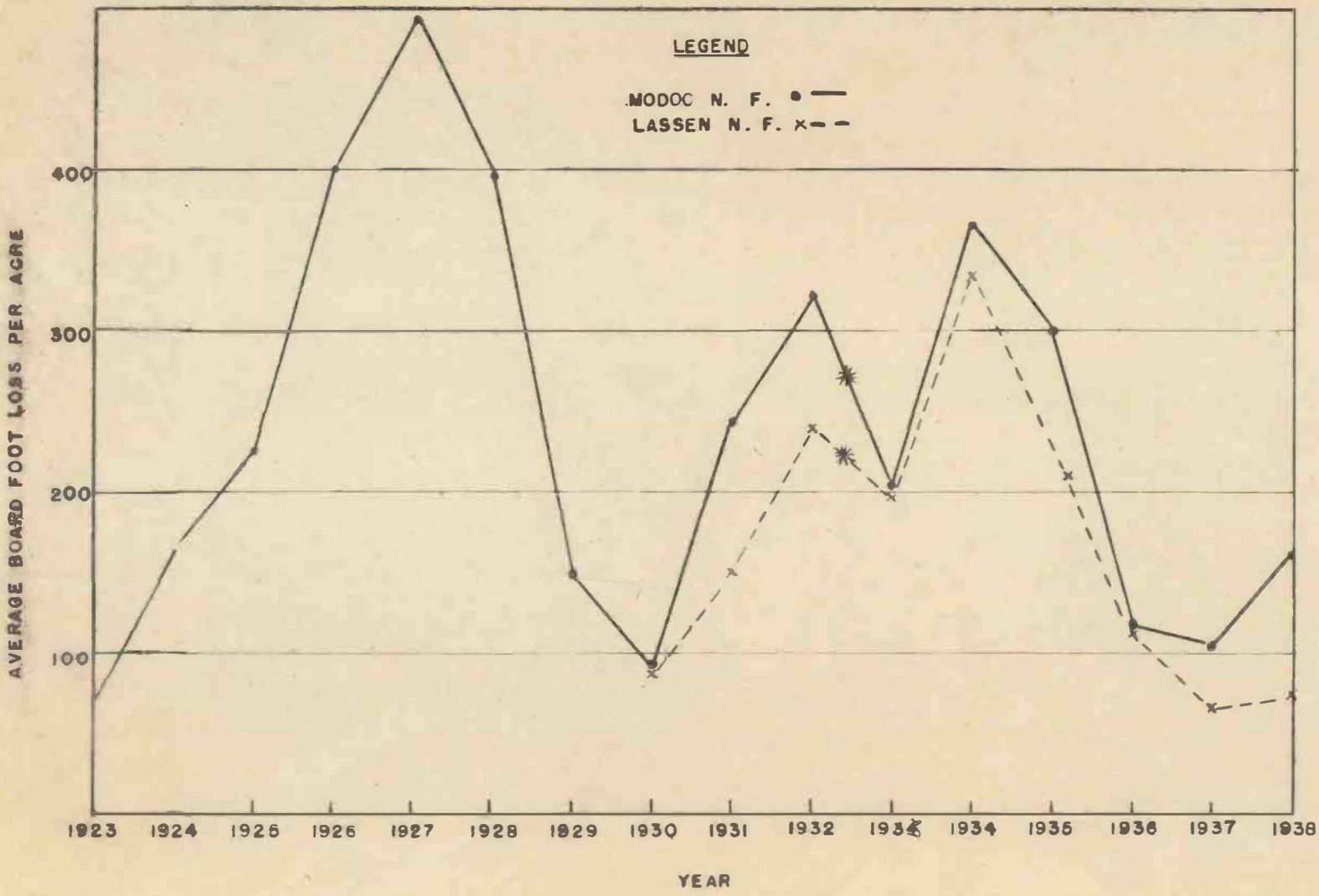
## INTRODUCTION

An examination of the insect loss records, from permanent sample plots in northeastern California from 1923 to 1938, immediately impresses one with the fact that such losses are not at all static. Rather, they seem to be in a constant state of fluctuation, and years in which they appear at equilibrium are indeed few. The question immediately arises as to whether these fluctuations show any indications of regularily or cyclical tendency. It is my purpose to set down my impressions on the possible existence of a regular cyclical fluctuation in these losses and I will grant at the start that much of the following discussion is based upon opinion, but founded on factual data wherever such are available. My premise, then, is that such a cyclical fluctuation does exist, based upon the following information.

## CYCLICAL FLUCTUATIONSIN LOSSES

Figure I shows the trend in annual losses from permanent sample plot records in the Modoc from 1923 to 1938 and in the Lassen from 1930 to 1938. This figure tends to show that there appears to have been two distinct cycles in losses since 1923. These appear to be of seven year duration with the peak in both cases having been reached the fourth year following the low point in the cycle. Note that in the first cycle the low point was in 1923 followed by a steady rise in losses until the peak year in 1927. The following year the declining trend had started and this continued until the low year of 1930. This was seven years after the previous low year of 1923. Again as in the preceding cycle the upward trend

# INSECT LOSS TRENDS IN NORTHEASTERN CALIFORNIA




* NOTE - HEAVY WINTER KILLING OF BROOD OCCURRED IN 1932 AND IN FEBRUARY 1933 WHICH IS PROBABLY RESPONSIBLE FOR THE DROP IN 1933 LOSS

Figure 1

started the year following the low and continued until 1932. Following 1932 a drop in loss occurred in 1933, but this is probably due to unusually heavy winter killing of all stages of the insect inDecember 1932 and February 1933. However, the effect of this severe winter killing was only temporary because the trend continued up in 1934 when it again attained another peak, this time in the Second Cycle. This peak year followed seven years after the previous peak in 1927. Again as in the previous cycle, the down trend started and continued to a low point in 1937 which was also seven years after the previous low in 1930. The 1938 losses exceeded those of 1937 and present indications are that the 1939 losses will show an increase over those of 1938.

Records for losses in the Lassen are available only since 1930, but note the marked similarity in trends for the Lassen when compared with the Modoc.

Figure 2 offers a comparison of the two apparent cycles, the first from 1923 to 1930 and the second from 1930 to 1937. The curves in Figure II have been fitted from the original data in Figure I by the use of a second degree parabola using the formula $y = a+bx+cx^2$. Note the close agreement in the trends in the Modoc for Cycle I and Cycle II. The first cycle was higher, but the same general trend may be noted in both. During Cycle II the Modoc and the Lassen show very close agreement in the general trend of losses. The question of course can be raised as to whether this may not be mere coincidence. That this close agreement is due to mere chance alone seems very remote. Rather it appears to be due to some, as yet, unexplained physical or biological factor or combinations of these.

Figure II to follow page 2

# COMPARISON OF CYCLICAL FLUCTUATIONS OF INSECT CAUSED LOSS

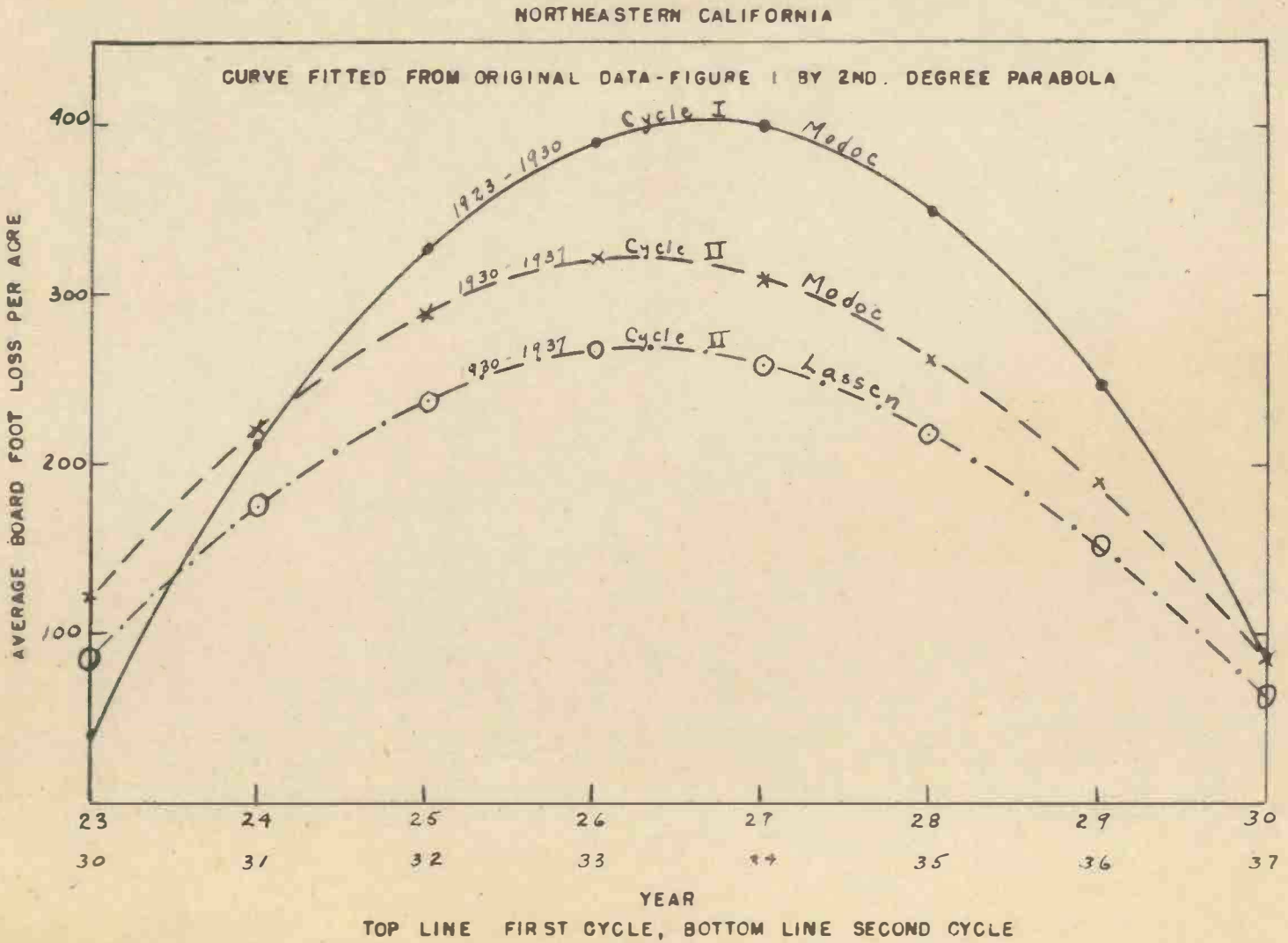



Figure II

## LOSS TRENDS AND PRECIPITATION

The weather, particularly moisture, is claimed or blamed as being responsible for a number of things and the natural tendency is to attempt to correlate this cyclical fluctuation in loss with precipitation records.

The only permanent weather station in the Modoc where records areaavailable since 1923 is the one located at Fort Bidwell. This station is a considerable distance from the majority of permanent plots from which loss records were taken, but this seems the best information available. Data of total annual precipitation from this station have been used in Figure III where this factor has been plotted with average volume loss per acre. Such an attempt at gross correlation of these two factors does not indicate any striking relationship. Granted, there are a few years where low loss coincides with high precipitation, and where high loss is associated with low precipitation, but there are too many inconsistencies to make this relationship significant. For example, 1927, the peak year of losses since records are available, coincides with a year of high precipitation, over 16 inches. It might be argued that this high precipitation was instrumental in starting the cycle downward the following year. If this is granted, then how can we explain a rising trend in loss in 1926 following a year of almost equal precipitation of over 15 inches. Another marked exception occurs in the rising trend of loss together with grouping in 1938 which followed two years of extremely favorable precipitation, both years over 16 inches. My own opinion is that total precipitation does not explain this apparent trend and that it is likely controlled by some biotic factor within the insect itself or associated biological systems.

COMPARISON OF PRECIPITATION AND LOSS CYCLES

MODOC 1923 TO 1938

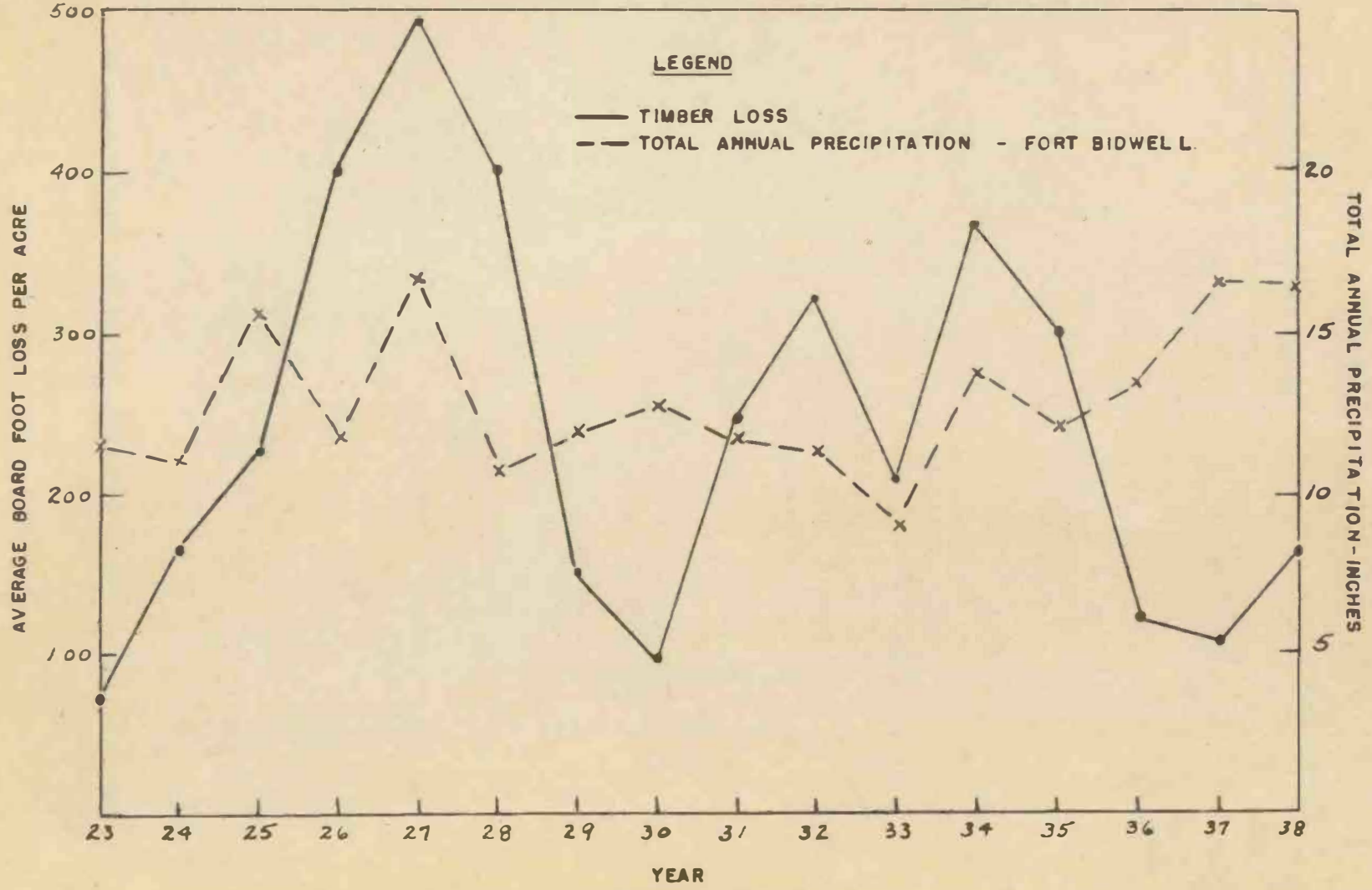



Figure III

## LOSS TRENDS AND INSECT POPULATIONS

In view of the fact that annual precipitation failed to show a marked correlation with the loss trend, an attempt was made to correlate insect population counts with this trend.

Some of the early work of the Berkeley laboratory was concerned with counts of number of beetles attacking and number of adults emerging per square foot of bark surface. These early studies were carried on from 1917 through 1926. Keen (1) summarized the results of this early work an d concluded that such records were of little use in predicting subsequent insect trends. However, his graph of the comparison of average emergence per square foot of bark surface and total infestation (figure IV, his figure VII) gives some indication that population density and loss records are, at least in part, correlated. The early records from 1917 to 1923 showed little agreement with the loss trend, but it must be remembered that, during this period, sampling was confined annually to but a small number of trees. During this time only an average of one foot of bark from 36 trees was examined annually. With the meagre amount of data and the extreme variation between samples, it is not surprising no correlation was found to exist. Lack of correlation in this instance might be due alone to inadequate sampling. During the three subsequent years, 1924 to 1926, samples were considerably increased to 438, 245 and 364 square feet of bark examined annually. With this considerable increase in samples for that period it may be noted, figure IV, that there is a very close agreement between population density and loss trend. Population counts were discontinued after

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(1) Keen, F. P. Report of the Forest Insect Laboratory, Stanford, 1928. Analysis of Brood Statistics of the Western Pine Beetle.

Figure IV to follow page 4

# COMPARISON OF EMERGENCE AND TOTAL INFESTATION
## JENNY CREEK UNIT

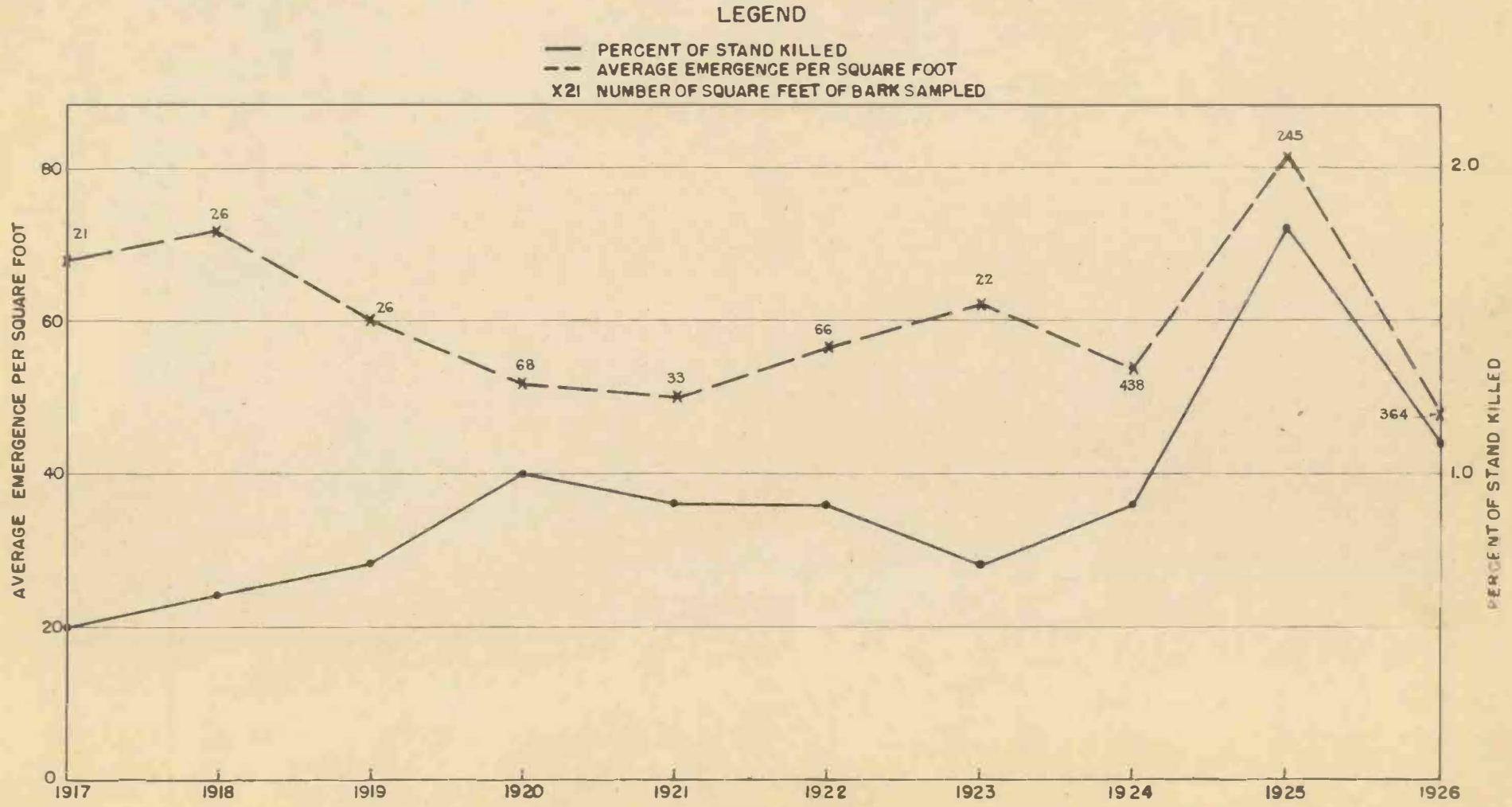


Figure IV

1926 and apparently were not made again until 1933 when Salman and Bongberg (2) carried on emergence counts for each brood from 1933 to 1935 in connection with their studies on the biology of the western pine beetle. Figure V was constructed from data in their table IV, page 10. From this figure there appears to have been a close correlation between population density and loss trend during the period covered by their study. The population density index used in figure V was obtained by multiplying the average emergence per square foot of bark by the number of infested trees. This is strictly an artificial figure, but should serve as a useful index for the total population. This figure appears to show that the population of beetles in the study area increased 10 fold from brood 1 in 1933 to brood 3 in 1934 and brood 1 in 1935, then a sudden reduction in population occurred in brood 2 in 1935 to bring the population down to approximately its original level in brood 1, 1933. Note the close agreement between the population trend and loss trend for this three year period. Unfortunately no population counts have been made since 1935. The results of these two studies appear to show that losses and population density may be associated and might justify further studies of this nature in the future.

## PRACTICAL APPLICATION OF CYCLICAL LOSS DATA

If such a cyclical fluctuation as has been pointed out does in fact exist, this would offer us a powerful weapon for use in predicting future loss trends. Assuming the existence of a regular cycle, then, the

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(2) Salman, K. A. and Bongberg, J. W. 1936. Berkeley Station Report. A Review of the Results of Some Recent Studies on the Biology of the Western Pine Beetle.

Figure E of Item page 5

# COMPARISON OF INSECT POPULATION DENSITY WITH TIMBER LOSS

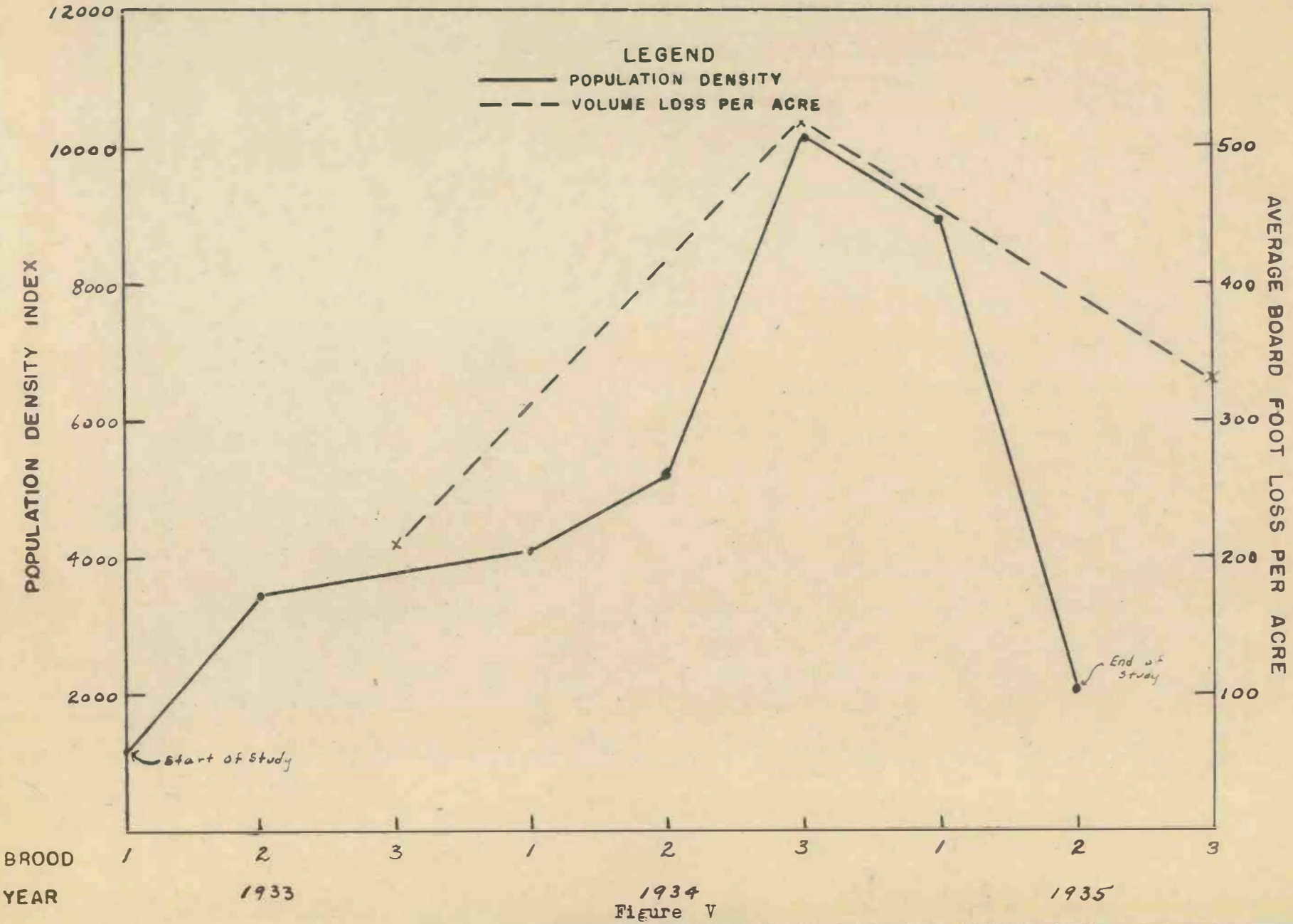


Figure V

increase in loss in 1938 followed by an apparent further increase in 1939 would logically be expected because the cycle is again on the up swing. Further this would lead us to expect another peak year of loss in 1940 or 1941.

The question of the existence of such a cycle is of great importance in our recently initiated Climatic Influence study. If such a cycle exists and is predominantly governed, let us say, by some biotic factor, then the same intensity physical factor is expected to have a different effect, depending on the phase of the loss cycle. If the cycle is downward, a favorable physical factor might be expected to cause it to go down faster, but if the loss trend is upward, the same intensity factor might only tend to dampen the swing of the pendulum rather than completely stop it.

Of course, it may be that when we are able to break down the physical factors of the environment by definite place and short periods we may find some factor or combination of factors which will explain this trend, but personally I expect the dominant factor in cyclical loss fluctuation to be biotic rather than physical. This would indicate the need for further attention being given to population studies in an attempt to develop a simple sampling technique for making brood counts along with records of timber loss.